TEST PROCEDURE

TP 709G	
Title Hot Soak Evaporative Emission Test	**Page Number** 1 of 15
Originator Thaddeus J. Cieslak Jr.	**Supersedes** TP 709D
Responsible Organization Vehicle Testing (VT)	**Computer Program** 1260S
Type of Test Report Computer	**Data Form Number** NA
Report Distribution Testing Programs Branch files, Certification Division, and Program Office requesting the test	**Implementation Date** 06-03-97

Implementation Approval

Original Test Procedure Authorized by EPCN #110 on 06-08-92

Revision Description

(1) 02-25-98 The purpose of this change is to revise the procedure as described in EPCN #227.

Note: Specific brand names in EPA/EOD procedures are for reference only and are not an endorsement of those products.

Table of Contents

Attachments

1. Purpose

(1) The purpose of this procedure is to quantify hydrocarbon evaporative emission losses which occur when a vehicle is parked and the hot engine is off. These measurements are added to those obtained by the required "TP 705, Diurnal Evaporative Emission (Heat Build) Test" to measure evaporative hydrocarbon losses occurring during motor vehicle operation.

Form 709-01 documents the 1996 One-hour Hot Soak Test sequence. These measurements are added to those obtained by performing TP 717, "Enhanced Diurnal Evaporative Emission Test."

2. Test Article Description

Vehicles that require evaporative emission testing

3. References

3.1 "Code of Federal Regulations," Title 40, Part 86, Subpart B, Sections 86.105 through 86.107, 86.130, 86.138, and 86.143

3.2 "Environmental Protection Agency (EPA)Laboratory Safety Manual"

3.3 Memo, M. Reineman, March 1, 1989, Subject: "Ethylene Glycol Spills During Evap Testing"

4. Required Equipment

4.1 Sealed Housing for Evaporative Determination (SHED) enclosure with:

4.1.1 Purge fan — capable of reducing hydrocarbon concentration from test level to ambient levels between tests

4.1.2 Cooling package and mixing blower — 200 cubic feet per minute (cfm) to 1,000 cfm max.

Equipment used: AESi Model 7500 SHED

4.2 Hydrocarbon emission analyzer system — Flame Ionization Detector (FID)

Equipment used: Beckman Model 400 hydrocarbon analyzer

4.3 Hydrocarbon (HC) Analyzer Recorder — Evaporative emission hydrocarbon data recording system, strip chart potentiometric recorder, on-line computer system, or other suitable means.

The system used must have operational characteristics (signal-to-noise ratio, speed of response, etc.) equivalent to or better than those of the signal source being recorded, and must provide a permanent record of results.

Temperature recording system — strip chart recorder or automatic data processor. The system used must be capable of recording each temperature at least once every minute, resolving time to ±15s and resolving temperature to ±0.75 °F.

The recorder shall have a time accuracy of ±15s and a precision of ±15s.

The temperature recording system (recorder and sensor) shall have an accuracy of ±3 °F.

Equipment used: Soltec strip chart recorder, Model 3316, to record hydrocarbon emission and SHED temperatures

4.4 Temperature sensors, thermocouples — Type "J" thermocouples, iron-constantan; 2 channels available for vehicle fuel tanks, 1 primary and 1 auxiliary fuel tank thermocouple.

Two thermocouples fixed for monitoring SHED ambient air, 1 fixed for monitoring SHED inlet cooling water temperature, and 1 fixed for monitoring SHED outlet cooling water temperature.

Equipment used: variety of thermocouples

4.5 Barometer — centrally-located and must agree within ±0.03 inch of mercury of the corrected mercury column

Equipment used: Bell & Howell digital barometer

4.6 Stopwatch available for drivers

4.7 Digital clock set to the master time clock and located at each site

Equipment used: fabricated to meet our requirements

4.8 Event timer for marking the time on strip chart traces for all recordings

Equipment used: fabricated by our Electronic Support Group to meet our requirements

4.9 Combustible Gas Detector — capable of detecting combustible vapors, opening the SHED enclosure door, and sounding the alarm

Equipment used: GasTech Model 1220

4.10 Form 702-01, "Vehicle Fuel Exchange" See TP 702 for this form.

Form 705-01, "Evaporative Emission Test." The form is required to record both the diurnal and hot-soak data. See TP 705, Diurnal Evaporative Emission (Heat Build) Test, for this form.

Form 709-01, "Enhanced Evaporative One-Hour Hot Soak Data" The form is required to record the 1996 one-hour hot-soak data. See TP 717, "Enhanced Diurnal Evaporative Emission Test."

An Evaporative Emission Test Guideline is posted on each Sealed Housing for Evaporative Determination (SHED), see TP 705.

Form 902-01, "Test Status Report"

"Vehicle Specification Report"

5. Precautions

5.1 Care must be taken when moving test vehicles in and out of the SHED enclosure to minimize the possibility of damage to the SHED or the test vehicle.

5.2 Special attention should be given to monitoring the SHED ambient temperature to assure that it does not exceed 86 °F, particularly for those vehicles known to emit significant amounts of heat following engine shutdown.

5.3 Both inlet and outlet water temperatures must be above 68 °F prior to the vehicle entering the SHED.

5.4 Any discrepancies in equipment, deviations from the prescribed procedures, and all other problems must be reported to your team leader.

5.5 If at any time the SHED's combustible alarm sounds, the SHED door should automatically open and the purge blower should activate. Complete by manual operation if this automatic feature fails to function.

5.6 The operator must use the real-time monitor clock displayed in the soak area for recording the time the event occurred.

5.7 If the strip chart recorder power has been off for any period of time, an equal period of time with the recorder power on is required for instrument warm-up. A 1-minute power off requires a 1-minute warm-up, and so on, up to a 1-hour maximum warm-up.

(1) 5.8 Prompt notification of your supervisor and the Calibration and Maintenance Coordinator in Quality Control Group is required any time the SHED exhaust system monitoring light is observed on continuously.

5.9 The SHED test will be canceled if large coolant leaks are observed during vehicle operation on the dynamometer.

5.10 The test will be aborted if large vehicle coolant leaks are observed in the SHED.

5.11 If HC hang-up is greater than 4 ppm is encountered, inspect the vehicle for possible cause and notify the Calibration and Maintenance Coordinator in Quality Control Group.

6. Visual Inspection

Before each test, ensure that any exhaust piping is sealed and inspect the SHED for obvious leaks, holes, other damage (e.g., escape hatch and Tedlar ceiling), and possible hydrocarbon sources (e.g., spilled vehicle fluids, paint cans, etc.).

7. Test Article Preparation

The SHED operator is responsible for assuring that the following preparatory steps have been completed prior to the hot soak test.

7.1 Prior to the completion of the Federal Test Procedure (FTP) driving cycle, check that a stopwatch is in the test vehicle in a place easily accessible to the driver.

7.2 Purge the SHED for a minimum of 5 minutes or until the hydrocarbon concentration in the SHED is at ambient levels.

7.3 At the start of the urban dynamometer test (TP 707), cool the SHED by placing the water system in the “pre-cool” mode. The temperature of the inlet and outlet cooling water must be raised to above 68 °F by switching the cooling package to the “hot-soak” mode approximately 5 minutes before the test vehicle enters the SHED so that no SHED surfaces are below 68 °F.

Both the inlet and outlet water temperatures are monitored and, if they are both above 68 °F, the vehicle may enter the SHED.

(1) 7.4 Check the SHED exhaust system monitoring light above the strip chart recorder.

If the light is observed on continuously, notify a senior technician and the Calibration and Maintenance Coordinator in Quality Control Group.

(1) 7.5 For 1978 FTP test, verify that the data listed in TP 705, Steps 7.6 and 7.8, have been recorded on Form 705-01 and the strip chart. For 1996 Enhanced Evaporative Emission test, ensure that the required data is recorded on Form 709-01 and the strip chart.

8. Test Procedure

The SHED operator is responsible for assuring that the following steps are completed.

101 Calibrate the FID analyzer.

Select the lowest available HC sampling range on the FID instrument multiplier.

Start the Soltec 5-pen strip chart recorder; set the chart speed to 2 centimeters per minute (cm); begin recording the SHED ambient temperature and hydrocarbon concentrations for zero, span, and sample.

The calibration readings must be stable. A stable trace is a minimum 30-second segment in which the maximum and minimum points differ by no more than 1% of full scale.

The numerical value of the reading is the end point of the operator's visual linear fit of the trace. This reading must be within 0.4% of full scale of the posted span point.

(1) In some unusual circumstances, the span reading may not be within 0.4% of full scale from the posted set point.

If the FID is spanned incorrectly and the difference between the actual set point and the required set point does not exceed 5% of full scale, a calculation may be performed to correct for the calibration offset.

Notify a senior technician in such cases.

Zero: Select the zero gas. Adjust the flow rate to 4.0 standard cubic feet per hour (scfh), if necessary. Adjust the instrument zero potentiometer until an accurate zero reading is obtained.

Span: Select the span gas. Adjust the flow rate to 4.0 scfh if necessary. Adjust the instrument gain potentiometer until an accurate span reading is obtained.

Zero: Select the zero gas and check the zero.

If the zero and span readings are accurate within the tolerance (±0.4%), the calibration is complete.

If the zero has shifted out of tolerance, adjust it to zero.

The analyzer must then be spanned and the zero checked again until there is no out-of-tolerance shift in the zero calibration or span calibrations.

(1) **Note:** If a stable reading cannot be obtained, the instrument should be repaired or replaced. Adjustment of the analyzer flow rate should not be necessary if the regulator is working correctly. Make the required flow rate adjustments and continue testing.

Notify the Calibration and Maintenance Coordinator in Quality Control Group as soon as possible if either condition exists.

102 Set the analyzer to the sample position, turn the sample pump on, and adjust the flow rate to 4.0 scfh if necessary.

On the strip chart, identify all calibration areas, the range used, and the calibration set points.

Label the strip chart with the following standard markings to indicate :

initial zero set points - the number “zero”

initial span set points - the word “span”

verified zero set points - the number “zero” with a check mark “√”

verified span points - the word “span” with a check mark “√”

a range change - write “R/C HC 14-16”

the initial HC reading - the letters “BG”

the final HC reading - the word “sample”

103 Turn the cooling system to the “hot-soak” mode approximately 5 minutes before the vehicle enters the SHED. Check that the inlet and outlet water are in a range of 68-72 °F.

If they are not, notify the Calibration and Maintenance Coordinator in Quality Control Group.

104 Set the Soltec chart drive at 2 cm/min. Put the FID in sample mode and start recording HC sample readings, the SHED ambient temperature, and cooling water temperatures.

105 (Driver) Start the stopwatch (or other time device) immediately at the completion of Phase 3 of the exhaust emission test.

106 (Driver) Upon completion of the hot transient exhaust emission sampling period, close the vehicle engine compartment, move the cooling fan(s), disconnect the vehicle from the dynamometer and the exhaust sampling system, and then drive at minimum throttle to the vehicle entrance of the SHED enclosure.

107 (Driver) The vehicle’s engine must be stopped before any part of the vehicle enters the enclosure. Push or coast the vehicle into the SHED enclosure.

Open the trunk, luggage compartment, and/or hatchback and check that no other enclosures remain sealed. All windows that can be opened must be opened. Remove the test documentation from the vehicle.

108 As soon as the seal is inflated and the SHED door is sealed, start the event marker, which will mark all the strip chart traces. This is the Hot Soak t = 0 point. The event timer will continue to mark the strip chart traces at 5-minute intervals. When the SHED is sealed (t = 0), the driver must stop the stopwatch timer.

The enclosure doors must be closed and sealed within 2 minutes of engine shutdown and within 7 minutes after the end of the exhaust test.

(1) 109 On Form 705-01 for 1978 FTP test or 709-01 for 1996 Enhanced Evaporative test, record the following Hot Soak Initial readings:

AMB. TEMP, BARO "HG, HC RNG, and the HC SAMPLE (from the strip chart at the t = 0 point). Also record the HOT SOAK START TIME from the real-time monitor clock displayed in the soak area.

The driver records the following under ELAPSED TIMES: END 505 TO ENG OFF (the time from the end of the exhaust emission test to engine shutoff, M, SEC) and the ENG OFF TO SHED CLOSE (the time from engine shutdown until the SHED enclosure is sealed, M, SEC).

110 Verify the analyzer calibration. Turn off the sample pump and select the analyzer span mode.

Span Check: Do not adjust the gain setting. Select the span gas and span check the FID, allow the reading to stabilize, and check that the reading is within tolerance limits.

Zero Check: Do not adjust the zero setting. Select the zero gas and zero check the FID. Allow the reading to stabilize and check that it is within tolerance limits.

(1) If the calibration points do not return to within 2.0% of full scale of the posted set points, or if a stable reading cannot be obtained, repeat the check. Notify a senior technician if any checks are not within the tolerance limits allowed.

If the calibration check is within tolerance, place the analyzer in the sample mode, turn on the sample pump, leave the chart drive on 2 cm/minute, and record continuous HC sample and temperature traces.

On the strip chart, identify all calibration points, the range used, deflections read, and calibration checks.

(1) 111 Monitor the SHED ambient temperature, particularly during the first 15 minutes of the hot soak. If adjustment is needed, notify a senior technician or the Calibration and Maintenance Coordinator in Quality Control Group.

(1) On Form 705-01 for 1978 FTP test or 709-01 for 1996 Enhanced Evaporative test, record the SHED identification number, the analyzer site number, barometer reading, FID range used, initial sample deflections read, and the initial SHED ambient temperature.

112 If the sample reading goes above the posted span point and you have completed the calibration verification has been completed, turn off the sample pump, calibrate the next highest available range (see Step 101), and return to the sample position.

Turn on the sample pump and continue to record the HC sample reading on the strip chart.

113 At approximately t = 45 minutes, turn off the sample pump and calibrate the lowest usable range (see Step 101). The sample reading should be at least 20% of full scale (unless the lowest usable range is being used) and not be above the posted span point for that range (unless the highest available range is being used).

If you are above the span point, calibrate the next highest range (see Step 101) and use that range.

If the reading is above the span point on Range 16 and the analyzer is switched to Range 19, the reading will be below 20% of full scale, which is acceptable in this situation.

114 Put the analyzer in the sample mode; turn on the sample pump for a continuous HC sample trace for the remainder of the test.

115 At t = 60, the event marker will mark the HC sample trace and the SHED temperature traces.

If a time other than 60 minutes is to be used (e.g., 59.5 min. or 60.5 min.) to indicate the end of the hot soak, the traces must be marked and a time entered on the strip chart corresponding to that end time.

(1) 116 On Form 705-01 for 1978 FTP test or 709-01 for 1996 Enhanced Evaporative test, record the following Hot Soak Final readings: Amb. Temp, Baro “HG, HC RNG, and the HC Sample (from the strip chart at the t = 60 point or as described in Step 115.)

(1) 117 On Form 705-01 for 1978 FTP test or 709-01 for 1996 Enhanced Evaporative test, record the Hot Soak End Time from the real-time monitor clock displayed in the soak area (or the time as described in Step 115).

118 Turn off the event marker.

119 Verify the analyzer calibration (see Step 110).

120 Turn off the strip chart drive.

(1) 121 Deflate the SHED door seal and open the SHED door. Close the trunk. For 1996 Enhanced Evaporative tests, do not drive the vehicle from the SHED, push or crab it to the VTSHED. Otherwise, remove the vehicle from the SHED and park it appropriately.

(1) 122 On Form 705-01 for 1978 FTP test or 709-01 for 1996 Enhanced Evaporative test, record the HOT SOAK T MAX (the maximum SHED ambient hot soak temperature as indicated on the strip chart).

(1) 123 On Form 705-01 for 1978 FTP test or 709-01 for 1996 Enhanced Evaporative test, under Elapsed Times, record the total Hot Soak time (H, MIN).

(1) 124 For 1978 FTP test, deliver all the forms and strip charts to Data Control and stamp the time of delivery on the back of Form 705-01.

For 1996 Enhanced Evaporative test, the data remains with the vehicle until the completion of the 2-day or 3-day diurnal.

9. Data Input

9.1 For 1978 FTP test, verify that the following data have been recorded on Form 705-01:

MFG Code, Vehicle ID, FTP Test Type, Test Date, Diurnal Start Time (standard 24-hour clock time), Hot Soak T Max, Elapsed Times, FTP Test #, Diurnal End Time, Hot Soak Start Time, Hot Soak End Time, Heat Blanket #, and the Technicians ID#.

Verify the following Diurnal and Hot Soak Initial and Final data have been recorded: SHED #, Analyzer Number, Amb. Temp, BARO “HG, HC RNG, and the HC Sample.

For 1996 Enhanced Evaporative test, verify that the following data have been recorded on Form 709-01:

MFG Code, Vehicle ID, FTP Test Type, Test Date, Start Time, Hot Soak T Max, Elapsed Times, FTP Test #, Hot Soak End Time, and the Technicians ID#.

Verify the following Hot Soak Initial and Final data have been recorded: SHED #, Analyzer Number, Amb. Temp, BARO “HG, HC RNG, and the HC Sample.

(1) 9.2 Verify that the following data have been recorded on the strip chart:

Date, Shed Identification Number (SOO #), Analyzer Site Number (AO #), Test Number, Vehicle ID #, Strip Chart Recorder Equipment Tracking Identification Number (ET #), Temperature Achiever Number (LFE #), Chart Speed, and the Technician’s ID #.

9.3 On the strip chart, identify all calibrations, initial HC sample readings, final HC sample readings, calibration checks, fuel tank temperatures, SHED ambient temperatures, and SHED water temperatures.

(1) 9.4 For 1978 FTP test, Form 705-01 is taken to the data processing window, where it is placed in the "In" box along with a work order requesting the data be processed. For 1996 Enhanced Evaporative test, Form 709-01 is taken to the processing window.

10. Data Analysis

10.1 For 1978 FTP, all data and documentation are reviewed for accuracy and completeness. Form 705-01 is processed to generate a SHED report printout.

For 1996 Enhanced Evaporative test, the Hot Soak Initial and Final data are transferred to the "001-REVSHED1.0." computer program for processing. This program generates the "VTSHED Report" See TP 717 for details.

(1) 10.2 For 1978 FTP tests, computer programs on LCS are used to calculate the evaporative emission for both the diurnal and hot soak tests. Calculations are based on the net SHED volume and the initial and final measurements of the SHED ambient temperature, barometric pressure, and SHED hydrocarbon concentration. Data from the diurnal and hot soak tests are handled separately in the computer, and the reported results represent their sum.

For 1996 Enhanced Evaporative tests, computer programs are used to calculate the evaporative emission for the hot soak test. Calculations are based on the net SHED volume and the initial and final measurements of the SHED ambient temperature, barometric pressure, and SHED hydrocarbon concentration. Data from the hot soak test is added to the results of 2-day or 3-day diurnal evaporative test. See TP 717 for details.

10.3 All forms and test records are verified by a qualified technician who did not record the data. The verifying technician checks the data for completeness, accuracy, and compliance with EPA regulations.

He/she will write his/her identification number and date in the "Verified By" area of the forms. On the strip charts, the technician will write his/her identification number and "OK." This certifies that the data are accurate and complete.

10.4 HC span and zero points are verified for all analyzer calibrations.

10.5 Each HC sample reading on the analyzer strip chart is verified.

(1) 10.6 SHED temperature traces are checked to assure that readings have been correctly identified and tolerances have been adhered to during the 1978 diurnal heat build and the 1978 or 1996 hot soak tests.

11. Data Output

(1) For 1978 FTP tests, the SHED Report is generated, it is checked against the input data on Form 705-01 and "OFFICIAL VALUES" is stamped on it, thereby indicating completeness and acceptability of test results.

For 1996 Enhanced Evaporative test, the data is reviewed prior to processing the final results. See TP 717 for details.

12. Acceptance Criteria

These criteria must be met for the test to be valid according to the guidelines set in the Code of Federal Regulations:

12.1 Prior to completion of the dynamometer test run, the SHED shall be purged to ambient hydrocarbon concentration levels.

12.2 The FID hydrocarbon analyzer must be calibrated immediately prior to the start of the hot soak test and before analyzing the final HC sample.

12.3 FID calibrations must be set to within 0.4% of full scale of the posted set points (unless the linear algorithm calculation method is used).

After HC sampling, calibrations are checked and must return to within 2% of full scale of the posted set points. All calibration readings must be stable according to the definition in Step 101.

12.4 All windows that can be opened are opened, including those in the rear area of vans and pickups; the luggage compartment, trunk, and/or hatchback must be open during the hot soak. Van rear doors must be opened, and pickups with caps on the rear must be opened.

12.5 The SHED door must be sealed within 7 minutes from completion of the exhaust test, and SHED enclosure doors must be sealed within 2 minutes of engine shutoff.

12.6 The total hot soak time must be 60 minutes ±0.5 minutes and begins when the SHED enclosure doors are sealed.

12.7 Ambient temperatures encountered by the test vehicle and SHED interior surfaces must remain within 68-86 °F at all times during the hot soak test.

12.8 SHED inlet and outlet water temperatures must remain within 68-86 °F at all times during the hot soak test.

13. Quality Provisions

13.1 Approximately 5 minutes prior to the vehicle entering the SHED, the SHED inlet and outlet cooling water temperatures are raised to a minimum of 68 °F and a maximum of 72 °F to ensure that all SHED surfaces are above 68 °F before the vehicle enters the SHED.

13.2 The hydrocarbon analyzer flow rate is kept at a constant 4.0 scfh during FID calibration and sample analysis.

13.3 The FID analyzer flame routinely burns on a 24-hour basis to improve analyzer stability.

If the FID is off, a minimum 30-minute warm-up is required after lighting.

13.4 The analyzer range on the FID analyzer is calibrated immediately prior to sampling and the calibration is verified immediately after a sample is analyzed to ensure minimal analyzer drift.

13.5 A continuous hydrocarbon sample may be taken to provide a record of evaporative emission during the hot soak test.

13.6 When the strip chart recorder power has been off for any period of time, an equal period of time with the recorder power on is required for instrument warm-up.

A 1-minute power off requires a 1-minute warm-up, and so on, up to a 1-hour maximum warm-up.

13.7 All clock times are taken from calibrated digital clocks provided at the sites.

13.8 Time-marked strip charts are used to ensure compliance of the 60-minute time constraint of the hot soak.

13.9 Variations from the procedure are documented on Form 903-01.

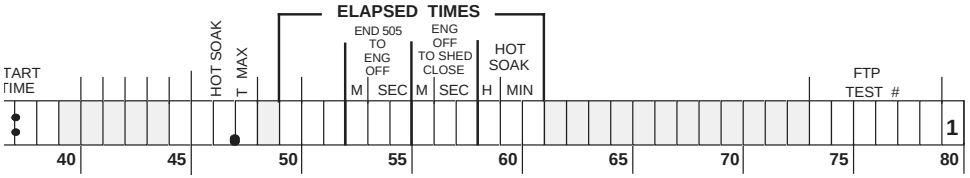
13.10 A SHED exhaust system monitoring light was added to ensure isolation of the SHED from the exhaust system negative pressure.

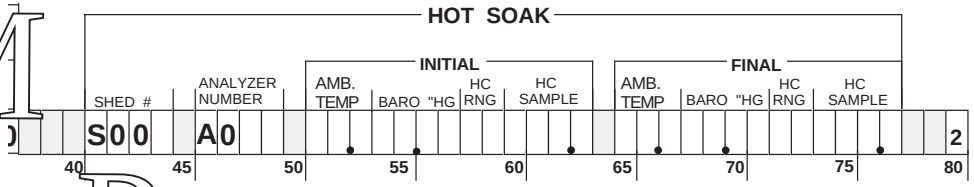
(1) 13.11 The technician follows the sequence of steps on Evaporative Emission Test Guideline, posted on each SHED, recording data on Form 705-01 or Form 709-01, as needed.

13.12 The technician’s identification number must appear on all forms and test records, certifying that the data are accurate and complete.

tive One-Hour Hot Soak Data

l all windows are open.





Hot Soak End Time: _____

SAMPLE